AMENDMENTS TO THE SPECIFICATION

Please amend the following paragraphs in the specification as follows:

[0012] A third embodiment employs a winglet having a dihedral of -60 to -90 or about +90 degrees. ~~This winglet or a portion thereof~~ A leading edge flap mounted on the winglet may rotate about an axis perpendicular to the plane of the inboard portions of the wing. The actuator can be placed in the axis of the wing spars. This embodiment allows increased yaw control from aft placed sideforces, and contributing drag differentials at the winglets due to the winglets or a combination of the winglets and ailerons. It could be possible to reduce or eliminate a larger center fin and rudder.

[0059] **FIGURE**s **2A**, **2B**, and **2C** illustrate side, top, and three-dimensional perspective views of an embodiment of portions of wings for usage on aircraft **100**. Wings **102** couple to a strake **108** that couples to aircraft fuselage **110** and extends along a portion of the aircraft fuselage **110** to leading edge **112** of wings **102**. Strake **108**, generally a small aspect ratio lifting surface with large sweep angles, typically functions as a vortex lift generator. A leading-edge flap **116** may be coupled to the strake leading edge **114** ~~**118**~~. However, this leading edge flap **116** is not necessary in all embodiments. If present, strake leading-edge flap **116** can extend over a portion of the length of strake **108** or can extend the full span of strake **108**. As shown in FIGURE 2C, strake leading-edge flap **116** is a simple or plain flap. In the simple flap, a portion of the leading edge **114** ~~**118**~~can have a hinged pivot **120** or can be driven by a wheel on rail type of mechanism as in commercial jets. The pivot or other moveable structure enables a surface of strake leading-edge flap **116** to move or extend downward. Leading-edge flap **116** can be controlled to improve aerodynamic flow fields for flight at Mach numbers different from the Mach number to which the aircraft design is optimized. Operation of the strake leading edge flap improves aerodynamic performance at off-design conditions. Strake leading-edge flap **116** can also reduce lift ahead of spillage at an off-design condition and maintain a low sonic boom signature.

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[0060] In the embodiment depicted, strake **108** typically functions as a leading edge flap device configured to function as a subsonic leading edge even at supersonic conditions and a

vortex lift generator positioned in front of the leading edge of wing **102**. Wing **102** typically has a smaller sweep angle and a larger aspect ratio than strake **108**. Strake **108** creates spiral vortices by separating flow at its leading edge **114** ~~118~~. Flow reattaches on the wings' upper side, producing a nonlinear lift due to depression on strake **108** and on portions of wing **102**.

[0039] Referring to **FIGUREs 2D** and **2E**, pictorial diagrams respectively show bottom and side views of embodiment of a leading edge strake flap **116**, particularly showing a swept hinge line **113** ~~117~~of the strake flap **116**. The swept hinge line **113** enables strake flap rotation without unsealing the flap **108** from the fuselage **110**. **FIGURE 2E** ~~1E~~ depicts the range of motion **119** of the leading edge strake flap **116**.

[0040] Referring to **FIGUREs 2F** and **2G**, schematic pictorial diagrams show top views of an embodiment of the leading edge strake flap **116** to illustrate aerodynamic influence of the flap **116** in operation. As Mach number is reduced, as shown in **FIGURE 2G** in comparison to **FIGURE 2F**, the leading edge flap's influence moves ahead of the wing, shown by movement **121**. Therefore, the optimal deflection of the leading edge strake flap **116** tends to change when Mach changes. In addition, sonic boom lift distribution constraints tend to benefit from deflection. From another perspective, flight not constrained for sonic boom has a reduced drag penalty when the strake leading edge flap **116** is deflectable. The outboard section can trap all the upwash generated by the inboard wing, behind the Mach cone angle but ahead of the inboard wing leading edge. This makes the outboard wing a more efficient place to generate lift than otherwise possible. Integrating this outboard section with sonic boom minimization, by keeping the equivalent area less than or equal to the George-Seebass-Darden ideal equivalent area definition, allows the aft load needed for minimization to be met with less induced drag. **FIGUREs 3** and **3B** further teach such wingtips.

[0041] **FIGURE 3A** depicts wing **102** in further detail. Aircraft wing **102** mounts onto aircraft fuselage **110**. Leading edge **122** extends along the wing inboard **124** to outboard **126**. Strake **108** couples to aircraft fuselage **110** and extends from the fuselage to leading edge **122**. As shown, leading edge **122** comprises a Krueger flap **128** outboard of strake **108** and inboard of a simple flap **130**. Krueger flap **128** and simple flap **130** generally have different leading

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edge structures. The Krueger flap 128 may extend over a range of leading edge **122** and functions o reduce vortex drag at supersonic cruise speeds, increase aft lift, and reduce trim drag while providing a reduced sonic boom signature. Generally, leading edge flaps bend or extend a surface downward along a forward portion of the wing. The entire leading edge may be a single structure or may have multiple leading edge segments with leading edge flaps of various types as known to those skilled in the art. For example, in some embodiments, Krueger flap **128** can extend from strake **108** to the wing tip. Krueger flap **128** couples to leading edge **122** at a relatively inboard portion of the wing adjacent strake **108**. Simple leading edge flap **130** couples to leading edge **122** of wing **102** and extends from junction **134** with Krueger flap **128** to outboard winglet **132**. Strake leading-edge flap **116** operates as a leading-edge device that, for subsonic performance, deflects to create an airflow field impinging on Krueger flap **128** so that the upper surface airflow field reduces or eliminates inboard vortices.

[0042] Wing **102** and strake **108** are both arranged at a sweep angle from the fuselage and form a swept wing that extends at a sweep angle from the fuselage. As depicted, wing **102** and strake **108** are configured with different sweep angles to form a swept wing that extends in a plurality of sweep angle segments **136**, **138**, and **140** from the fuselage. For example, the sweep angle of wing **102** differs from the sweep angle of strake **108**. Furthermore, the sweep angle of wing segment **138** inboard of junction **134** can differ from the sweep angle of wing segment **140** outboard of junction **134**. In other embodiments, the sweep angles may be the same for wing **102** and strake **108**. Wing segment 140 ~~Outboard section 40~~ may partially trap the upwash generated by inboard segments **136** and **138**.

[0043] Referring to **FIGUREs 3B** and **3C**, schematic pictorial diagrams show top pictorial views of an embodiment of an aircraft lift device with a Krueger flap **128** in respective non-deployed and deployed positions. As shown in **FIGURE 3B**, with the Krueger flap **128** in the retracted position, the leading edge **122** transitions inboard to outboard along the retracted Krueger flap **128** to the junction with the leading edge plain flap **130**. The intersection between the retracted Krueger flap **128** and the leading edge plain flap **130** forms a sharp leading edge angle (or discontinuous increase in chord), termed a dog-toothed arrangement **131**. As shown in **FIGURE 3C**, the deployed Krueger flap **128** meets and seals with the deflected outboard leading edge plain flap 130.

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[0044] Not only may the sweep angle of the segments differ, the dihedral angle of these segments may differ as well. For example, the dihedral angle of the segment outboard of junction **134** may be negative or anhedral. As previously discussed an anhedral of about 30° provides improved roll control. An anhedral of about 90° provides improved directional control. In either case, the ground effect may be enhanced to provide improved take-off performance. In this instance, wing **102** takes on a gull like profile with outboard winglet 140 inclined downward from the lateral axis of the aircraft. This profile is depicted in FIGURE 4. Here, segment **136** has a positive dihedral angle relative to the aircrafts lateral axis. Segment **138** is approximately parallel to the aircraft's lateral axis. Segment **140**, which in this embodiments comprises winglet 132, is anhedrally oriented relative to the aircraft. Anhedral segment **140** increases directional stability and control, increase the ground effect during takeoff, and provides positive wave interference with the nacelles **106**.

[0045] Modifying wing tip flow with outboard winglets alters the trailing tip vortex produced by an aircraft wing and enhances the aircraft's overall performance. Winglets take advantage of the strong sidewash that occurs at the wing tip. This sidewash meets the winglet 132 at an angle of attack and produces a side force. From this the winglet 132 forms its own horseshoe vortex system. The winglet vortex system partly cancels the wing tip vortex at the wing-tip/winglet junction 134 and therefore the main tip vortex now forms at the tip of the winglet 132. By moving at the tip vortex out of the plane of the main wing with the anhedral orientation of the winglet 132 relative to the aircraft's lateral axis, the downwash over the wing's surface can be substantially reduced. This has the advantage of reducing the induced drag. In addition, the side force produced on a winglet 132 when resolved, provides a forward thrust component or negative drag. These two effects more than offset the parasitic drag produced at the winglet junctions and thus provide a beneficial effect on the overall drag of the aircraft. In addition to providing aerodynamic efficiency and both roll and directional stability and control, the control surfaces on the winglet 132 in the form of leading or trailing edge devices allow the position of the aerodynamic center of the aircraft to be actively controlled during supersonic flight with minimal control surface deflections. This further aids in minimizing trim drag.

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[0046] In operation, leading edge flaps, including Krueger flaps 128 and simple edge flaps 130, extend for low speed operations during takeoff, approach, and landing. In a

particular example, leading edge flaps can be extended up to and beyond 130 degrees to improve lift-to-drag ratio in a range around 1.5 to 2.5, resulting in better climb performance, and reduced takeoff and landing field length. Additionally, leading edge flap devices on the outboard winglet 132 can provide a measure of roll control at supersonic speeds and directional control with proverse roll effects.

[0047] **FIGURE 4** depicts a front profile of aircraft **100** with anhedral outboard winglet **132**. The inboard portion 136 of the wing may comprise about 85% of the wing span and does not require a negative dihedral. Leading edge **122** has incorporated therein leading edge flap devices **128, 130** which are controlled to reduce the vortex and trim drag of the wing at supersonic cruise and increase at lift for the boom while providing a low boom signature. The anhedral orientation of the winglet increases directional stability and increases the ground effect during take-off as well as providing positive wave drag interference with nacelles **133**.

[0048] Leading edge devices **128, 130** may be used in conjunction with trailing edge devices to reduce drag at subsonic cruise conditions. The use of the leading edge flap **128, 130** in conjunction with a trailing edge may reduce drag. In addition, the leading edge flaps **130** on winglet **132** may be used for roll or directional control. The anhedral angle of winglet **132** ~~**140**~~ depends on the specific configuration as there is an optimal combination of wave drag reduction at supersonic cruise and increased lift at take off, as well as directional stability. These three factors influence how much anhedral or downward inclination of the winglet **132** there is in relation to the aircraft's lateral axes. This relation may be predicted or empirically determined by the desired combination of properties to be exhibited by the supersonic winglet **132**.

[0049] **FIGURE 5** illustrates one embodiment of leading edge flap **130**. As shown, leading edge flap **130** is a simple leading edge flap having a cross-sectional form transitioning from a sharp or pointed form **202** at the outboard end **204** to a rounded form **206** at Krueger flap junction **208**. The variable form of leading edge flap **130** from the outboard sharp point transitioning to a more rounded form in the inboard direction to a junction with the Krueger flap reduces or minimizes sharp edges or gaps in the wing leading edge. Some aircraft embodiments may omit the simple flap **130** in favor of a Krueger flap(s) **128**, or other similar device know to those skilled in the art, that extends to the wing tip.

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[0053] As the Mach cone angle moves farther aft the higher the lift is carried vertically, dihedral raises the height of the wing as one goes outboard. However, too much dihedral makes the aircraft roll during sideslip. To maximize the height of the wing for sonic boom minimization without saturating roll control during sideslip, the wing should have higher inboard dihedral and an anhedraled wing tip. As shown in **FIGURE 9B**, winglet **816** takes advantage of its greater moment arm to counter the roll from greater inboard dihedral. By making greater inboard dihedral controllable, this anhedraled winglet 816 improves sonic boom minimization Additionally, winglet **816** typically outboard of the fuel extent allowing the fuel bearing portion of the wing **808** to be flat or dihedraled, easing pumping fuel, and allows movement as a control surface. This much smaller, lower sweep outboard winglets **816** works without negatively impacting fuel volume and bending loads as much.

[0059] From the stowed position, rotary actuators **760** may rotate Kruger flap **750** downward and forward from the lower surface **756** of the wing **754**. As shown, Krueger flap **750** depicts one type of a suitable rotary actuator **760** suitable for usage on a wing or other airfoil. In general, any Krueger flap with appropriate configuration, aerodynamic configuration, and actuating mechanism can be used. Generally, a suitable Krueger flap has an actuating mechanism capable of forming the wing leading edge configuration into a rigid airfoil structure at multiple different operating positions maintaining short and efficient load paths. Furthermore, a suitable Krueger flap has a control linkage mechanism that is stable at the different operating positions and deflects downward when actuated through a range of selected rotational angles while maintaining a substantially smooth wing surface with an aerodynamic, relatively constant radius of curvature. The actuating linkage operates to controllably stow and deploy the flap **750** during takeoff and landing, and for usage as a speed brake, if desired, during either high or low-speed in-flight operating conditions.

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